2004 GALVESTON BAY INVASIVE SPECIES RISK ASSESSMENT
INVASIVE SPECIES SUMMARY
Created by: Environmental Institute of Houston, University of Houston-Clear Lake
and the Houston Advanced Research Center

Common Name: Hydrilla, waterthyme, Florida elodea

Latin Name: *Hydrilla verticillata*

Category: Aquatic Plant

Place of Origin: Asia

Place of Introduction: Florida

Date of Introduction: 1960

States Effected:

Alabama	Connecticut	Georgia	Mississippi	Tennessee	Washington
Arizona	Delaware	Louisiana	North Carolina	Texas	
California	Florida	Maryland	South Carolina	Virginia	

http://plants.usda.gov/cgi_bin/plant_profile.cgi?symbol=HYVE3 (Accessed 17 March 2003)

Habitat:
"Plants grow in canals, constructed lagoons, channelized streams, ponds, lakes, and impoundments." http://www.wes.army.mil/el/pmis/plants/html/hydrilla.html (Accessed 17 March 2003).
"Hydrilla is capable of growing in virtually any water body, including lakes, streams, ponds, and canals. While it generally grows submerged, it often forms dense mats at the surface which are very detrimental to the ecosystem. The plant reproduces by stem fragments carried by people or boats. Seeds and capsules can also disperse through water or be carried by animals. Due to these highly specialized growth habits, hydrilla has spread rapidly along the coastal United States." http://bc4weeds.tamu.edu/hydrilla.html (Accessed 17 March 2003).

Attitude (aggressive, etc.):
"This species is probably the worst naturalized aquatic weed in many places. Plants form large, dense populations that displace native species and impair water use. Undoubtedly, plants are spread from lake to lake by fragments attached to boat motors. Presumably the capsules or seeds, or specialized buds and tubers (turions), are dispersed by water. The capsules are sometimes spiny and probably dispersed by animals." http://www.wes.army.mil/el/pmis/plants/html/hydrilla.html (Accessed 17 March 2003).
"Major nuisance impact on US systems ($8M/yr in Florida)" http://www.apms.org/plants/hydrilla.htm (Accessed 17 March 2003).

Physical Description:
"The plants grow submersed, are mostly perennial but sometimes annual, and have horizontal stems in the substrate forming tubers under certain conditions. The stems are ascending and usually are widely branching with ultimate numerous branchlets that, under certain conditions, form turions (actually bulbil-like structures). The stems can be 8.5 m long and grow to the surface of the water where the branchlets extend horizontally. The leaves are 1-nerved, sessile, whorled, 3-12 at a node but mostly 5 or more, mostly shorter than 1.5 cm long, linear to lanceolate or rarely widely ovate, broadest at the base, the sides nearly paralleling to near the acute tip terminating in a single spine cell. The leaf margins are serrate, the teeth visible to the naked eye. Fresh leaves are notably rough to the touch. The midrib on the upper surface is often tinged with red and on the lower surface usually has 1-celled sharp teeth or spines. Flowers are unisexual, arising from the leaf axil; plants are monoecious or dioecious. The flowers are small, less than 6 mm in diameter, translucent to white, on upper branches, and usually produced in the fall. The male flowers are solitary, small, short-petioled, breaking off the stem as buds and opening explosively on the water surface. Female flowers are solitary, subsessile but with a long threadlike structure that carries the flower to the surface." http://www.wes.army.mil/el/pmis/plants/html/hydrilla.html (Accessed 17 March 2003).
"Perenniating mostly from tubers, propogates from tubers, turions, root crowns, and fragments; partially evergreen; white flowers." http://www.apms.org/plants/hydrilla.htm (Accessed 17 March 2003).
"Hydrilla is a submersed plant with long slender stems. Hydrilla's leaves are small and grow in whorls of 4 to 8 around the stem. Leaves are small, linear, and pointed with serrate edges. Hydrilla produces small white flowers on the stalks." http://bc4weeds.tamu.edu/hydrilla.html (Accessed 17 March 2003).

Management Recommendations / Control Strategies: include references for existing site-specific strategies

"Foreign exploration for insects as biological control agents were conducted by Balciunas (1982, 1983, 1984, 1985) and Balciunas and Dray (1985). Five candidate species were investigated in subsequent quarantine studies (Balciunas 1987; Balciunas and Center 1988; and Balciunas, Center, and Dray 1989). The species that have been released in the U. S. are: hydrilla tuber weevil, *Bagous* *affinis*; and two hydrilla leaf-mining flies, *Hydrellia balciunasi* and *Hydrellia pakistanae* (Buckingham 1990; Center et al. 1991)." http://bc4weeds.tamu.edu/hydrilla.html (Accessed 17 March 2003).

http://bc4weeds.tamu.edu/weeds/aquatic/hydrilla.html (Accessed 17 October 2003).

"Potential for Restoration of Invaded Sites:

Restoration potential is likely to be lowest where, by whatever mechanisms, a species possesses unusual reproductive vigor and a wide range of adaptability, and, in its present settings, has few pests and predators; where it is well-established both in terms of numbers and range; and where the use of common and cost-effective control measures will also negatively impact native flora. *H. verticillata* has an unusually high level of reproductive vigor, and is also highly adaptable to different habitats. There are currently no known important native insect pests of *H. verticillata.* And in wildlands, the application of even selective herbicides can kill other aquatic plants and animals.. Unless and until biological controls become biologically and economically feasible, the potential for large-scale restoration of wildlands infested with is *H. verticillata* is probably very low.

Management methods currently include mechanical removal and drawdowns (controlled water drainage), herbicides, and the use of some biological controls.

Specialized machines are used for mechanically removing *H. verticillata*. This is not a widespread practice because of the high cost involved, (often over $1000 per acre,) and because of logistical constraints in large water bodies. Up to six harvests may be required annually due to the rapid growth rate of *H. verticillata* (McGehee 1979). Mechanical removal is mainly used for *H. verticillata* management only in areas that are in close proximity to domestic water supply intakes, in rapidly flowing water, and or when immediate removal is necessary. .

The high cost of harvesting *H. verticillata,* and its low nutrient value, greatly restrict hydrilla's potential crop value as a forage plant (Easley & Shirley 1974; Bagnall 1978)., such as for cattle feed (Easley and Shirley 1974; Bagnall 1978).

Drawdowns can be an effective mode of hydrilla control if the drawdown is performed while subterranean turions are developing in the fall, and prior to regrowth in the spring (Haller et al. 1976). Drawdowns for aquatic plant management are limited restricted to only those lakes or ponds having that have water water control structures, and have hydrologic characteristics that permit water levels to be controlled, and where. Additionally, the drawdown must not interfere or negatively impact other primary water uses, such as domestic or irrigation supplies, navigation, or hydrologic power. Even in drained lakes and ponds, however, subterranean turions may remain dormant and viable in organic substrates (Haller and Shireman 1983).

Several herbicides have been used to control hydrilla. Most effective have been the contact poisons copper sulfate (brand name Komeen and others) and endothal (brand name Aquathol and others), and the systemic herbicides fluridone and bensulfuron methyl. For both contact and systemic herbicides, concentration in the water column and exposure time are key variables determining effectiveness. Copper sulfate and endothal are non-selective herbicides, and copper sulfate is highly toxic to fish. Fluridone has been used to control *H. verticillata* in Lake Okeechobee in Florida with minimal to no long-term impact on native aquatic plants (Langeland 1996). Application rates will vary according to a number of factors, including water depth, water chemistry, whether the water is still or moving, and the size of the infestation. Getsinger and & Netherland (1997) report that the following formulations have been shown effective: for endothal, 2.0 mg ae/L for 48 hours or 3.0-5.0 mg ae/L for 24 hours; for fluridone, 15-30 ug/L for 20-40 days (minimum of 4 ug/L); and for bensulfuron methyl, 25 ug/L and higher for in excess of 42 days. The use of plant growth regulators such as fluridone and bensulfuron methyl is relatively recent, and is intended to reduce, but not to necessarily eliminate, *H. verticillata*. Less vigorous remnant plants may perform useful functions such as providing oxygen, stabilizing sediment loads, and creating habitat (Lembi and Chand-Goyal 1994).

Acetic acid in concentrations of 9-26 mmol/L (< (which is less concentrated than commercial vinegar) for 24 hours reduced growth by 50% in laboratory studies (Spencer and Ksander 1995). The use of compounds from native aquatic plant species with allelopathic properties has not been shown to be an effective control for *H. verticillata* (Jones 1995).

Although grass carp or white amur (*Ctenopharyngodon idella* Val.) is a biological control agent that effectively controls *H. verticillata* (Van Dyke et al.1984). Possession of this fish species, however, is illegal in many states because of the potential environmental damage that could result if escaped fish were to establish breeding populations. Sterile, triploid grass carp are available and legal by permit in some states in the U.S. Not all triploid grass carp are sterile, however, and every individual released needs to be genetically checked. Grass carp is recommended for small ponds or lakes and canal systems where the fish can be retained within the water body and where the removal of all vegetation is acceptable. There is no adequate method of recapture. Since Chinese grass carp prefer food other than *H. verticillata*, the likely impact on natural areas, and even managed systems is a reduction in the overall abundance of native aquatic plants, and the potential reduction in food and habitat for invertebrates, other fish, and waterfowl, are to be expected. Stocking rates for partial control have not been established.

Worldwide surveys for natural *H. verticillata* enemies were begun in 1981 in a cooperative study undertaken by the University of Florida-IFAS, United States Department of Agriculture, and U.S. Army Corps of Engineers. Snails consume large amounts of *H. verticillata* when they are present in high densities in enclosed experimental areas, but not in natural settings. Plant pathogens effective against *H. verticillata* under experimental conditions have been ineffective in the field (Charudattan and Lin 1974; Charudattan and McKinney 1978). Several pathogens have been identified from Asia, though but their effectiveness has yet to be tested (Shearer 1997).

Over 40 species of insects have been found that feed on *H. verticillata*. Several are presently being evaluated as potential *H. verticillata* biocontrols in the United States. Other insects from Australia are also under consideration (Balciunas et al.1996). *Bagous affinis* Hustache is a weevil that was discovered in Pakistan and India. Adults lay eggs on rotting wood and other organic matter. After hatching, the larvae burrows through the sediment until it encounters a *H. verticillata* subterranean turion, which it then feeds on and destroys (Buckingham and Bennett 1994). This insect is useful only where there are periodic lake drawdowns or intermittently wet and dry shorelines. Another *Bagous* sp. species has been released in the U.S. but has not become established. *Hydrellia pakistanae* Deonier is a leaf-mining fly that is very promising as a *H. verticillata* biosuppressant (Buckingham et al.1989). *H. pakistanae* is established in Florida, but its impact on *H. verticillata* has yet to be undetermined. *H. balciunasi*, released in 1989, has had limited establishment, apparently due to several factors including competition with other biological agents, parasitism by native wasps, genetic differences in *H. verticillata* types, and possible inbreeding depression (Grodowitz et al. 1997). An aquatic moth, *Parapoynx diminutalis* Snellen, was accidentally introduced into the United States (Del Fosse *et al.* 1976). The larvae of this moth can frequently be found feeding in large numbers on *H. verticillata*, though usually not until late in the growing season. Large areas may be defoliated but viable stems remain and the plant remains a problem." http://tncweeds.ucdavis.edu/esadocs/hydrvert.html (Accessed 17 March 2003).

Agencies Collecting Data:
Texas Nature Conservancy
Texas A&M University

References (includes journals, agency/university reports, and internet links):

1. STPL - http://www.wes.army.mil/el/pmis/plants/html/hydrilla.html
2. APMS - http://www.apms.org/plants/hydrilla.htm
3. TAMU - http://bc4weeds.tamu.edu/hydrilla.html
4. IFASa - http://aquat1.ifas.ufl.edu/hydrill.html
5. IFASb - http://aquat1.ifas.ufl.edu/hydcirc.html
6. ARS - http://www.nal.usda.gov/ttic/tektran/news/hydrilla.htm
7. NAPIS - http://www.ceris.purdue.edu/napis/pests/hyd/index.html
8. NWCB - http://www.nwcb.wa.gov/weed_info/hydrilla.html
9. FNA - http://flora.huh.harvard.edu:8080/flora/browse.do?flora_id=1&taxon_id=115981
10. TNC - http://tncweeds.ucdavis.edu/esadocs/hydrvert.html
11. WAPMS - http://www.wapms.org/plants/hydrilla.html

Available Mapping Information:
PLANTS - http://plants.usda.gov/cgi_bin/plant_profile.cgi?symbol=HYVE3
STPL - http://www.wes.army.mil/el/pmis/plants/html/hydrilla.html
NAPIS - http://www.ceris.purdue.edu/napis/pests/hyd/mgif/hdis.gif

Notes:
Water Bodies in Texas effected by Hydrilla:
http://nas.er.usgs.gov/plants/docs/hydr.html (As of Nov 2001)

Amistad Reservoir
Austin-Oyster
Austin-Travis Lakes
Bois D'Arc-Island
Buffalo-San Jacinto
Caddo Lake
Cedar
Chambers
Cross Bayou
Elm Fork Trinity
Farmers-Mud

Hubbard
International Falcon Reservoir
Lake Fork
Lake O'The Pines
Lampasas
Los Olmos
Lower Angelina
Lower Colorado-Cummins
Lower Devils
Lower Frio
Lower Guadalupe
Lower Neches
Lower Sabine
Lower Trinity-Kickapoo
Lower Trinity-Tehuacana
Lower West Fork Trinity
Middle Brazos-Lake Whitney
Middle Colorado
Middle Guadalupe
Middle Sabine
Navasota
Navidad
Richland
Sabine Lake drainage
San Marcos
South Laguna Madre
Toledo Bend Reservoir
Upper Angelina
Upper Neches
Upper Sabine
Upper San Antonio
Upper Trinity
Upper West Fork Trinity
West Fork San Jacinto
Yegua